United States
Department of
Agriculture

Forest Service

# Fire Management Notes

Volume 45 No. 3
1984

# Fire Management Notes

An international quarterly periodical devoted to forest fire management

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Department of
Agriculture

**Forest Service**

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# Today's Change, Tomorrow's Success

**Jerry E. Schmidt**

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*Washington, DC*

Be *professional*, be *right*, and be *there* is what the Director for the Forest Service Aviation and Fire Management organization was emphasizing to managers 5 years ago. He was saying this in light of the changing roles of fire managers and also to emphasize the characteristics necessary for being successful.

The advice is no less true today, for we are in the midst of many other changes in policy, management style, technology, and philosophy about fire management. One change has been brought about by Affirmative Action, a program not always widely understood or accepted by everyone. The primary purpose of the Affirmative Action program is, I believe, to remove the effects (vestiges) of past discrimination. However, most of the attention has been on complying with Title 7 of the 1964 Civil Rights Act and the 1979 Supreme Court ruling in the Weber Case. These have each added special emphasis to the intent and purpose of the law requiring equal opportunity for all, and today many managers have Affirmative Action targets on which to focus their efforts. However, there is another aspect of this change that managers should focus on. It has to do with more than just having women and minorities to fulfill targets. It has to do with being stronger leaders and more assertive managers. We need to capitalize on the opportunity to use other points of view and different skills and to expand the capabilities of our Aviation and Fire Management organizations.

There are outstanding potential benefits resulting from the Affirmative Action program that have not been fully realized. Traditionally, in most Aviation and Fire Management programs, white males, like myself, have been the dominant force. We have always been very successful in learning, analyzing, and managing. We have always demonstrated with pride our ability to change with the times, to be most progressive, and to keep abreast of the "state of the art." However, I do not believe that we were ever aware of how, at the same time, we were working within self-imposed constraints. Constraints, that is, for our predominantly white male organization. Until recently we were not involving everyone at all levels because we did not notice or utilize the interest from women or minority groups other than those working in the crews and support services. Now, as adjustments are occurring, we are asking what will happen to our "high standards," our "excellent traditions," our "capability for success." What will happen to "us the white males"? The answer is that, if we are what we think we are, everything will improve. Here are some of the benefits:

## Benefits of a Balanced and Integrated Work Force

Diversity provides different points of view, different perspectives on how to do things, solve problems, develop policies, communicate, and manage changes.

White males currently represent 90 percent of those permanently employed within Aviation and Fire Management. The characteristics of our organization have developed around a comfort level based on years of tradition rooted in white male society and extending throughout the educational systems, professional societies, social interests, and communities. These perspectives and points of view are based on traditions and supported by all of those who have grown up with, and are now contributing to, the system. This system contains traditional roles, expectations, and steps one must go through to be an authority or to be successful. All of this tends to put most of us in the same philosophical box, generally agreeing on the big picture.

But what about people who are not a part of this system? They do not necessarily "buy the program" or perceive being successful in the same way. They have other points of view, different solutions. We too often hang onto our traditions and comfort levels, and we are limited and unaware of the benefits others can offer. People with different perspectives can contribute something white males cannot; and this could benefit our program, its balance, cost-efficiency, effectiveness, safety, and other features.

The diversity helps avoid "tunnel vision," and enables all of us—whites and minority members, men and women—as an organization, to build a broader base of insights. Many social analysts credit the success of the United States to the diverse nature of our society and the individual's opportunity to contribute. In fact, if it were not for the diversity of cultures, our country would not have progressed as well as it has.

The involvement of women and minorities provides the organization new and additional networks for information and technology transfer within the organization, the professions, and the community.

Expanding the employment selection pool increases healthy competition. This should raise the level of organizational capability. A more diverse array of subordinates requires supervisors and managers to be more competent.

Affirmative Action is timely because it could help facilitate the management of change in other areas such as with the requirement to utilize the latest technologies, communicate most effectively, and challenge provincial methods, policies, and philosophies (i.e., implementing appropriate suppression, reorganizing interagency coordination, reducing costs, and reducing size of our organizations).

Sometimes women and members of minority groups, because of their different life experiences, can contribute viewpoints and strengths that many white males do not share. For example:

- Women are usually *more aware* of whole systems ("... we have had to live with both the in-laws and our own family. We had to keep everybody somehow functioning together. We couldn't isolate ourselves, but men in their work environment frequently could."(*1*)).
- Women often can understand and use the whole communication system, including body language and intuition, much more effectively than most men.
- Many women can cope with uncertainty, partly because "we have lived for so much of history with other people making decisions."(*1*).
- If minority people are of different cultures, based on different priorities, they can at times perceive weaknesses and potential strengths not noticed by others;
- Women and minorities understand cultural oppression and, as times change, we all need to understand it and deal with it more in the future.

Women and members of minority groups can bring wisdom and different strengths into the work force. Generally they are capable of meeting the physical and intellectual challenges and demands of any position. Also, many women fall easily into the acceptable range for physical task performance by "male standards."

**Opportunities for Fire Managers**

The following are some of the opportunities leaders, program managers, and directors have for managing today's changes for tomorrow's successes.

*Leadership*

- Be an advocate for women and minority opportunities in all positions and at all levels. Stop going along with the old tales of what women and certain minorities generally cannot do. For many people the silence among leaders implies that they may condone or at least empathize with the white male backlash or, on the other hand, that the leaders may need help from others to force-feed Affirmative Action.
- Be alert for and address kneejerk or extreme reactions. Overt reactions are the easiest to work with (or maybe work around). The covert reactions are tougher to recognize and more harmful.
- Where appropriate, participate personally in "Outreach." The program is usually facilitated by personnel management staff and includes initiating contacts with various schools, associations, and other groups that include predominantly women or minorities. The idea is to inform people of opportunities and review the "how to's" for employment or a career. This not only helps to increase the pool of candidates for employ-

ment but also is worthwhile investment for the future.

- Recognize the changes in our culture and lead in making our Affirmative Action program work. Your option is to let the Civil Rights managers and specialists do it for you.
- Avoid the kidding about "women in a man's world." Its cumulative effects are, in many cases, intolerable. Otherwise, be normal with hazing, humor, and consideration.
- Understand that the involvement of people who are not white males is going to call for organizational adjustments and changes. Manage the changes and recognize the benefits.

*Program Management*

- Ensure good communications throughout the work force. Often policies and their rationale are not uniformally understood. Also some women feel that their toughest barriers are men who do a good job but cannot communicate or effectively teach others.
- Ensure opportunities for women in fire suppression, aviation, and leadership assignments as well as dispatching, prevention, and fuels.
- Use the Co-Op Ed and the Upward Mobility programs, and gamble when anticipating the availability of positions needed for placement.
- Ensure opportunities for women and minorities in key activities such as training sessions (as trainees and instructors) and in key positions on overhead teams on ad hoc committees.
- Search for, analyze, evaluate, and correct provincial methods, procedures, terminology, and equipment that favor white males over others.
- Ensure that we do not expect the same behavior and responses from women and minorities that we have always expected of white males. Manage this and keep your eye on the "big picture" (your goal) and what's truly important.

As an example for fire suppression, we have always put a very strong emphasis on upper body strength, physical toughness, and endurance, but maybe we have relied on these qualities too much at times. Having the feeling of being physically elite and a "can do" or "never say die" attitude has probably contributed toward some accidents. With a little less emphasis toward being physically elite and with more emphasis toward teamwork and utilizing the diverse capabilities available from all human skills, we are apt to use more brain with the brawn. Some standards need to be adjusted and the end result, from a safety and cost-effective point of view, could improve.

- When practical, involve employees from all levels including white males, minorities, and women in major policy development and changes (use networks).
- Organize so as not to isolate women and minorities. We all perform much better with mutual support.
- Encourage and facilitate "networks" and "support systems." We all need peers to air our feelings and seek support.
- Ensure that women and minority employees receive the same benefits as others from mentors.
- Anticipate and, in a positive way, deal with backlash. The occurrence of backlash is natural and calls for your most effective communication and followup.

*Program Direction*

- Maintain a focus on our Fire Management goals and objectives and do not get concerned about masculine versus feminine or men versus women. Ask what do we need? What is truly important? What do we want? In other words, maintain a strategic vision of the future.
- Strive to help our organization adapt to change and attain an appropriate comfort level.
- Maintain a sense of humor, handle criticism, and help our organization learn, grow, and maintain its *balance*.
- Managing Affirmative Action in Fire Management is our *challenge*

and *our opportunity*—it need not be our problem. We can keep the strong, action-oriented, progressive organization we have always had. Remember, this is not an *us* versus *them* situation, it is *all of us together*. Let's be professional, let's be right, and let's get our act together. Remove the limits of self-imposed constraints, and demonstrate the spirit and leadership we have always been proud of.

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1. James, Jennifer. Changing sex roles and adaptive strategies. Women in Forestry 5(1): 9–14; 1983. ■

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# Training in Water Use Increases the Efficiency of Fire Suppression in the Pacific Northwest

**Bruce Keleman and Chuck Whitlock**

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The Pacific Northwest Region, region 6 of the USDA Forest Service, has adopted and modified a hands-on approach for training employees in the operation of water handling equipment and the use of water in wildland fire suppression. Although this training opportunity has been available for only 3 years, positive benefits can be identified regionwide.

Interagency training sessions of this type could be beneficial in other geographic areas where multiple agencies are responsible for suppressing fires on wildlands.

### History

The California Region, region 5 of the USDA Forest Service, began using a hands-on approach to training employees in the use of water handling equipment for fire suppression in the early 1970's. At that time fire managers had identified the need to improve their ability to work closely with other fire suppression agencies during periods of heavy fire supression activity. Improved skills, knowledge, communications, and suppression equipment were needed to accomplish the complex fire suppression operations often occurring in southern California.

From the beginning, these sessions proved to be very effective and by the mid-1970's several training sessions of this type were being offered in both the northern and southern zones of the region.

### Needs of the Pacific Northwest Region

Throughout the early 1970's the standardization of water handling equipment used for fire suppresion was discussed at several levels in the Pacific Northwest Region. The need for standardization was apparent, but so was the observation that much of the equipment being used in fire suppression was more frequently used for prescribed burning. Throughout the region many different types of engines evolved to deal with this dual usage. These rigs tended to be site specific in their function and also very different in operating characteristics and abilities. Similarly, the operators of many of these pieces of equipment were highly skilled in operating their own engines but were often at a loss if assigned to another engine from a different district, forest, or agency.

Overcoming these obstacles has not been simple. The value of the equipment already in use and the expense of training personnel is extremely high. However, the need to overcome basic safety problems and gain operating efficiency continues.

### The Pacific Northwest Region Makes a Commitment

In the fall of 1980, fire managers in the region made the commitment to begin improving the quality of water handling equipment and the skills of the employees hired to operate that equipment. A steering committee was appointed to organize a regional training session on the use and operation of water-handling equipment. The steering committee designed a 2-week-long course modeled after the region 5 academies but modified to meet the needs of its own region.

The first session was held at the Forest Service Training Center in Redmond, Oregon, in April 1981. About 30 trainees from the National Forests of Oregon and Washington, the Bureau of Land Management, the Oregon State Department of Forestry, and the Bureau of Indian Affairs attended. It was considered an outstanding success by the participants and the Director of Aviation and Fire Management. The training session was offered again in 1982 and 1983 and has continued to improve each year. The evaluations of the session have been very positive. Demand for trainee positions by several agencies has grown; in 1984, two separate 2-week sessions will be offered.

### Benefits of Water Handling and Equipment Use Training

Several direct benefits from the region's commitment to this session can be identified.

**Improved awareness of safety.** The responsibilities of each operator for safe vehicle operation has been emphasized.

**Improved operating skills.** Hands-on skills have been developed in areas from hydraulics to the preparation and deployment of hose packs.

**Improved maintenance of equipment.** Information on recommended maintenance for most of the common types of pumping equipment in use has been provided.

**Interchange of ideas and skills.** Standards for new equipment, the exchange of equipment between units, and the cross flow of information at the operational level in the organization and between agencies have resulted from the sessions.

**Managerial involvement.** The major commitment of money and time required by the session has helped focus the attention of management on the fact that, although the investment in water handling equipment used for fire suppression in the Northwest is extremely large, there is a need for continued intensive management, support, and direction in the use of water handling equipment.

## Summary

The evolution of the use of water handling equipment in the Pacific Northwest has taken a major leap forward since the commitment to improve training was made in the fall of 1980. Major improvements have been identified in the skill levels of water handling operators, and these improvements should continue as the two training sessions are held in 1984. This type of session could be adapted for use in other geographical areas of this Nation where interagency fire activities often occur. For information regarding specific course content and training/educational procedures, please contact Bruce Keleman, Wenatchee National Forest, P.O. Box 199, Chelan, WA 98816. ■

# A Teamwork Approach to Multiagency Fire Management

**Dan W. Bailey, Bruce Suenram, and Jim Costamagna**

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Forest and range lands throughout Montana are among our State's most valuable resources. Because Montana is dependent upon proper natural resource development and management, the protection of our resources is paramount. Due to the intermingled nature of Federal, State, and privately owned lands within Montana, the coordination of the protection effort by responsible agencies and individuals is essential.

Recent population settlement patterns add to the need for coordination. An increasing number of homes are being constructed on forested lands, escalating the potential loss of life and property resulting from fire. The increase in residential development coupled with the perennial threat of wildfires underscores the need for cooperation between structural and wildland fire protecton agencies.

The Missoula County Fire Protection Association provides an avenue for planning coordinated fire protection efforts and is indicative of cooperation by Federal, State, county, and municipal agencies within Montana.

*Ted Schwiden,* Governor of Montana

In today's changing social, political, and economic climate, western Montana fire protection agencies are teaming up to deal better with the complexities of wildland and structure fire protection. Problems that have plagued local agencies include duplication of efforts in all areas of fire management, including such things as poor or nonexistent radio communications, fire prevention programs that are duplicated by each agency, both aerial and fixed detection systems and overlap, and no real coordinated management system to deal with large fire incidents.

In 1981, 16 Montana wildland and structural fire agencies met to discuss opportunities to improve cooperation in dealing with the area's fire protection needs. The Missoula County Fire Protection Association (MCFPA) was formed as a result of this meeting. All local fire agencies—Federal, State, county, city, and volunteers—belong to the group. Area fire chiefs, fire management officers, and fire control specialists are included in the organization, which comprises over 300 local fire people.

### Organization Framework

MCFPA adopted a basic outline that is its operational framework, with fire protection being the common element and the responsibility of all members. Group members provide fire protection and service for either wildland and structural fires or both, maintaining and operating fire protection organizations for their jurisdictions.

MCFPA provides the opportunity for individual agencies to cooperate with and assist each other in all aspects of the fire protection field (prevention, detection, reporting, presuppression, suppression fuels management, and training), to the mutual advantage and benefits of all members. Examples include cooperatively appearing in community civic affairs such as the county fair, parades, service club presentations, and school programs. Other types of coordinated programs include fire prevention signing, utilization of fire equipment, and joint training of personnel (fig. 1).

### The Organizaton

MCFPA developed a basic organizational structure so that it could meet its objectives. The executive committee, a chairperson, vice-chairperson, and secretary-treasurer, oversees the general management and operations of the association. A finance committee works with the secretary-treasurer on financial matters.


**Figure 1**—*Improving services to the public is an important goal for the MCFPA. This firefighter is holding up one of the pieces of chimney cleaning equipment that local fire departments make available to the public free of charge.*

A public information officer was designated to handle public relations for MCFPA and to coordinate the public information and education programs of the individual agencies.

### The Working Teams

Four permanent working teams are responsible for meeting the objectives of the group. Each working team has a chairperson, who reports to the executive committee, and secretary.

**Fire Prevention Working Team.** This team is concerned with activities directed at reducing the number of fires that start, including public education (fig. 2), law enforcement, personal interaction, and reduction of fuel hazard.

**Fire Training Working Team.** The main task of this multiagency group is providing or coordinating a cadre of trainers and instructors in the area of fire management and structure fire.

**Fire Suppression Working Team.** This team is responsible for coordinating activities relative to actually extinguishing or confining a fire, including preparation and readiness.

**Emergency Medical Services (EMS) Working Team.** This team is responsible for coordination of activities relative to the work of emergency medical services through city, county, State, and Federal agencies.

### Activities of the Association

During the past 2 years, MCFPA has come a long way in promoting cooperative fire programs among agencies.

The Missoula Area Spring Fire News is a major fundraiser for the Association (fig. 3). The paper reaches over 100,000 residents of


**Figure 2**—*The MCFPA works with local schools to raise children's awareness of both the positive and negative aspects of fire. A poster contest during Fire Prevention Week produced these winners.*


MISSOULA AREA
SPRING FIRE NEWS

It can't happen to my home!

*Are you sure?*

Each year throughout the country about 112,000 fires start on forest, brush, and grasslands, burning over 5 million acres, destroying countless structures and killing over 30 people.

*Are you fire safe?*

SOME ADVICE TO FOREST HOME OWNERS

*In this issue:*

**Figure 3**—*The yearly fire newspaper is a major fundraiser and educational vehicle for the members of the MCFPA. Over 100,000 people receive this paper, which is paid for by local businesses.*

western Montana with 28 pages of articles on fire management, protecting and preventing structural fires, and many other aspects of fire safety.

In 1984, the Association began publishing a children's fire awareness magazine entitled *Fire Alert*. The magazine is developed for preschool through fifth grade and deals with both structural and wildland fire awareness.

A publication of tips on the safe burning of firewood has been developed by the Association in cooperation with the Forest Service, city and county health agencies, and private industry.

The Association has also been heavily involved in fire training—over 400 people have been trained in wildland fire and structure fire protection during the past 2 years. Mock fire drills involving both wildland and structure fire agencies have greatly improved working relationships and communications between agencies.

### Future

The MCFPA has provided the means of bringing together both structure and wildland fire agencies. Through improved fire management planning and coordination as well as better utilization of people, equipment, and technology, all agencies are benefiting from this approach to multiagency fire management.

To bring together 3 years of building working relationships and developing the cooperative program, the major emphasis of the group is to establish the Missoula Interagency Dispatch Center by the beginning of the 1985 summer season.

### Information

For additional information, please contact:

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# How Shape Affects the Burning of Piled Debris

**Von J. Johnson**

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Debris created during harvesting or clearing forest land is usually disposed of by chopping, chipping, burying, or burning. Slash for burning may be scattered or broadcast over the cleared area or it may be concentrated into piles. Burning broadcast slash is preferable when the slash is evenly distributed and is of sufficient quantity to carry fire. Broadcast burning is also preferable when slash consists mostly of small pieces that are not compacted or when postburn residue will not interfere with subsequent land use. Piling slash before burning is the best alternative when the volume of slash is not sufficient to sustain a broadcast burn or when the material to be disposed of is large and bulky. Piling slash is also preferable when the fuel moisture content is high or woody material is mixed with large quantities of organic or mineral soil. In this article I describe the results of a test to determine if the shape of a pile affects the burnout time of piled logging residue.

Piles are usually shaped indiscriminately at the discretion and convenience of the equipment operator. Forms may range from long windrows to round piles. When burned, the shape of the piles is claimed to influence the rate of fuel consumption (*4*). If this idea is correct, then the shape of piles has important implications for managing emissions produced from burning piles. Combustion rate is directly proportional to intensity, and the amount of emissions produced per unit weight of fuel is inversely proportional to intensity (*10*). An increase in fuel consumption rate would shorten burnout time and the consequent duration of emissions. The experimental work on pile shape and burnout time was performed at the Bladen Lakes State Forest of North Carolina and involved both small-scale tests and full-scale validation.

### Small-Scale Tests

In these tests, piles of longleaf pine needles that were ambiently conditioned and mixed for 2 weeks were constructed at a ratio of 0.133 times the size of the slash piles that would be burned later. Shapes were truncated and nontruncated windrows and circular piles (fig. 1). Because surface area and loading are critical for determining fire intensity (*8*), the tests were stratified to isolate any influence these characteristics might impose on shape. Round and truncated configurations, stratified by equal surface area and equal loading, were each replicated three times for a total of 12 tests. The scaled windrows were equal to the combined surface area of loading of the counterpart circular piles, all of which had the same basic dimensions (fig. 2). In all, 17 circular and 11 truncated piles were required for surface/area tests and 24 round and 17 truncated piles for loading tests. The piles were ignited by a centrally placed aerial ignition device (AID) in each circular pile and

**Figure 1**—*Scaled tests of round and cylindrical piles of pine litter, equal loading at 24:1.*

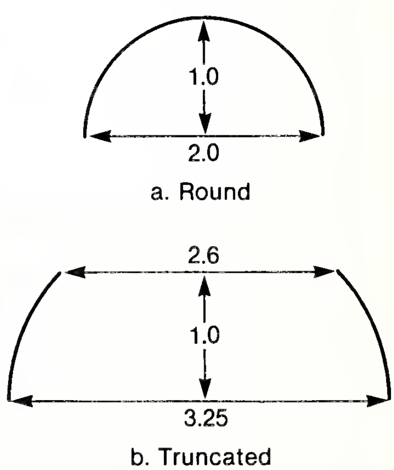


**Figure 2**—*Cross sectional dimensions (in feet) of round and truncated scaled piles of pine litter.*

a corresponding number of the devices equally spaced in the windrows. The plastic-encased potassium permanganate AID's were hand-charged with 1 milliliter of 50 percent ethylene glycol solution for a delay of about 30 seconds (*9*). Ignition form, timing, and placement were uniform for each windrow/hemisphere replication. Immediately before ignition, eight fuel moisture samples were taken randomly—four from the circular piles and four from sections of the windrows. Burnout times—the period from ignition to cessation of flaming and to cessation of visible emission—were estimated by three observers.

Although the level of moisture was high, averaging about 22 percent (table 1), the piles burned briskly. Windspeed averaged less than 3 mph, with a few isolated gusts reaching 5 mph. All burning was in full sunlight. The estimated times from completion of ignition to the last visible flame or the last visible smoke did not vary appreciably (less than 10 percent) between the three independent observers. A t-test disclosed no significant difference ($P<0.05$) in average burnout times between windrows and hemispheres, whether round or truncated. An F-test revealed that no differences ($P<0.05$) in burnout times could be attributed to shape, loading, or surface area. Burnout times for the truncated series averaged about 40 percent longer than the round series. Average fuel moisture contents of the 12 replications ranged from 14.8 to 26.2 percent. Linear correlation between burnout time and moisture content was negligible ($r^2=0.017$), with a slope not significantly different from zero. Correlation was only marginally improved by an exponential transformation ($r^2=0.059$ for $Y=ax^b$). These results strongly suggest that the shape has little influence on the combustion rate of piled fuel consisting of uniform size particles. The added implication that fuel moisture of 15 to 27 percent does not substantially affect the burnout rate of piled pine needles was also noted by Blackmarr (*2*).

**Table 1**—*Moisture content and burnout time of scaled piles of pine litter*

| Pile shape | Mean percent moisture (N=24) | Mean burnout time (min) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Hemispheres (N=9)[1] | | | Windrows (N=9)[1] | | |
| | | IF | IS | FS | IF | IS | FS |
| Round | | | | | | | |
| Equal loading | 17.9 | 6.0 | 10.1 | 4.1 | 5.5 | 11.8 | 6.2 |
| Equal surface area | 23.0 | 8.0 | 16.5 | 8.5 | 12.7 | 17.0 | 4.3 |
| Truncated | | | | | | | |
| Equal loading | 24.3 | 11.5 | 20.8 | 9.2 | 11.1 | 20.8 | 9.6 |
| Equal surface area | 21.35 | 13.6 | 24.0 | 10.4 | 16.3 | 24.9 | 8.6 |
| Mean | 21.6 | 9.8 | 17.8 | 8.1 | 11.4 | 18.6 | 7.2 |
| SD | 3.33 | 3.3 | 6.5 | 4.1 | 5.6 | 6.3 | 4.3 |
| Total No. of samples | 96 | 36 | 36 | 36 | 36 | 36 | 36 |

[1]IF=ignition to flameout, IS=ignition to smokeout, FS=flameout to smokeout.

## Full-Scale Validation

A full-scale validation of the equal loading, round series, was conducted in 1-year-old mixed hardwood and softwood logging slash. The windrow, abut 7 feet high by 15 feet wide by 246 feet long, was constructed on a 3.87-acre clearcut tract. Nearby, 24 randomly spaced piles, 7 feet high by 15 feet wide, were constructed in three contiguous tracts totaling 3.68 acres (fig. 3). Before piling, the broadcast slash was inventoried by the planar intersect technique described by Brown (*3*). Loading of piled material was reestimated twice, following methods suggested by McNab (*6*) and Mohler (*7*). To verify these methods, loading was again estimated in the windrow by removing and weighing two randomly selected 2-foot transverse slices (fig. 4).

There was no significant difference between the total net loading in the windrows and piles or between the windrow loading estimated by the planar intersect and the weighed sections (table 2). However, the variation in size class distribution

**Figure 3**—*Round piles, about 7 feet high by 15 feet wide, of mixed hardwood/softwood slash used in pilot test.*

**Figure 4**—*Material from a transverse 2-foot section of the windrow was removed, separated into size classes, and weighed.*

**Table 2**—*Estimated fuel loading in windrows and roundpiles*

| Fuel size class (inches) | Planar intercept (tons/acre) | | | | | | Weighed sections—windrow (tons/acre) |
|---|---|---|---|---|---|---|---|
| | Before piling[1] | | After piling[1] | | Net | | |
| | Windrow | Piles | Windrow | Piles | Windrow | Piles | |
| Duff | 5.0 | 5.0 | 3.7 | 3.0 | 1.3 | 2.0 | 2.04 |
| <¼ | 0.48 | 1.04 | 0.23 | 0.21 | 0.25 | 0.83 | 0.04 |
| ¼–<1 | 3.67 | 7.09 | 1.70 | 1.87 | 1.97 | 5.23 | 0.37 |
| >1–<3 | 2.44 | 3.30 | 1.28 | 1.08 | 1.16 | 2.22 | 5.50 |
| >3 | 16.08 | 11.22 | 4.09 | 3.87 | 11.99 | 7.35 | 7.93 |
| Total | 27.67 | 27.65 | 11.00 | 10.03 | 16.67 | 17.63 | 15.88 |

[1]Estimated from depth—McNab, Edwards, and Hough (*5*); Albrecht and Mattson (*1*).

**Table 3**—*Estimated total weight of fuel in windrow and piles*

| Method | Basis ($lbs/ft^3$) | Fuel weight (tons) | |
|---|---|---|---|
| | | Windrow | Piles (N=24) |
| Planar intercept | 33.0[1] | | |
| | 30.5[1] | 64.5 | 64.9 |
| Weighed sections | | | |
| Softwoods | 7.0[2] | | |
| Hardwoods | 7.4[2] | 61.4 | — |
| McNab (*6*) | 5.2[2] | 60.3 | 64.9 |
| Mohler (*7*) | 6.5[2] | 107.7 | 129.6 |

[1]Solid wood × particles.
[2]Includes interstices in pile not occupied with wood.

between the windrow and pile sites and estimating methods is apparent. About 13 percent of the windrow consisted of duff or organic soil and over half the loading was 3 inches in diameter or larger. Applying various weight estimation methods to the piled material gives a range in total loading of 58.9 to 107.7 tons (table 3). There is little apparent difference between the total weight as projected from the transverse samples and the weight derived by McNab's method. The total loading, estimated from the transverse sections, is based on an average solid density of 7.5 pounds of wood per cubic foot of pile. This density, which is influenced by size and species of residue and compactness of the pile, ranged from 7.0 to 8.0 pounds per cubic foot.

Total tractor time required to prepare the windrow was 17 hours; building the 24 piles required 21½ hours; thus, the same operator required about 25 percent more time to construct the round piles.

The piles and windrows were ignited concurrently with fuel boosters, consisting of 16 ounces of alumina-gel-thickened gasoline in plastic bags. These were centrally placed in each pile and at 14.75-foot intervals in the windrow. The boosters were ignited at 30-second intervals with a hand-held fuse, completing the ignition of the windrow and all piles in about 12 minutes. Average moisture of fuels less than ¼ inch in diameter at the time

of ignition was 8.7 percent. Ambient weather conditions were:

| | |
|---|---|
| Temperature . . . | 90 °F |
| Relative humidity . . . . | 42 percent |
| Wind . . . . . . . . . | 2–5 mph |
| Precipitation . . . | 6 days since 1.0 inches |

Maximum flame lengths of 40 feet were observed in the burning windrows 30 minutes after ignition. Maximums of 35 feet were observed in the piles 40 minutes after ignition. The windrow began to collapse about 1 hour after ignition; individual piles required 6 to 10 minutes longer to collapse. The differences in flame lengths and times from ignition to collapse may have been due to the distance between piles, which exceeded the 15-foot intervals between ignition points in the windrow. As ignition progressed along the windrow, the combustion rate may have been reinforced by heat transfer from previously lighted points.

Very little unburned material remained 24 hours after ignition, and few emissions were visible from either the windrows or piles. However, hot embers remained in all piles.

## Conclusions

Burnout time of brush piles does not appear to be influenced by the shape of pile. The combined surface area of many small piles is often greater than that for a comparable volume in windrows, and with more area that can be ignited, an increase in combustion rate of the pile is often incorrectly attributed to shape. Unless the intensity of ignition is directly proportional to the size (that is, volume) of the pile, burnout time will increase with size. With proportional ignition, larger piles should burn hotter with a lower emission rate per unit of fuel.

The burnout time of brush piles may vary because of differences in (1) maximum size of fuel particles, (2) porosity of the pile (the ratio of void volume to fuel volume), and (3) the distribution or blend of sizes of component fuel particles. But, surprisingly, moisture content in a range that allows ignitions to propagate has no more than a modest effect on burnout time. Large piles, whether round, elongated, or in windrows, afford less flexibility for discontinuing burning during marginal days. Once a debris pile is successfully ignited, extinguishing prior to burnout is difficult.

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# Prescribed Fire Management Training

**Jim Webb and Al Brown**

*Fire Staff Officer, USDA Forest Service, Fremont National Forest, Lakeview, OR, and Training and Safety Officer, USDA Forest Service, Aviation and Fire Management Staff, Portland, OR.*

The thin stream of burning fluid splashed onto the ground mat of pine needles, small limbs, and duff. An area about 3 inches in diameter began to char, and a ring of inch-high flames moved out from the burning center. An experiment in prescribed fire training begins after months of planning and hard work by the Fire Management Staff on the Fremont National Forest in southern Oregon.

Trainees from National Forests in the Pacific Northwest Region, the Modoc National Forest of the California Region, and Bureau of Land Management, Lakeview District, had gathered earlier at the Fremont National Forest headquarters in Lakeview, Oregon. They assembled to learn about and put into practice the use of fire by prescription in fuel systems of the Northwest.

There is considerable written information on the theory and practice of prescribed burning. Individuals have accumulated postgraduate degrees by demonstrating and documenting that conditions can be predicted when fire is applied to fuelbeds and contained to meet specific conditions.

Considerable work has been done by research scientists on fire and its effects on the resources. However, the effects of training on the abilities of workers from the National Forests have not been examined. At the Fremont National Forest, trainees from the California Region learned the state-of-the-art in prescribed burning, with most of their training devoted to the actual application of fire.

### Course Objectives

Over the last three decades, the natural role of fire in maintaining the balance of most forest and range ecosystems has been recognized by greater numbers of people. Considerable research supports these conclusions. Forest Service policy provides direction and guidelines to perform prescribed burning tasks. Two factors, however, have inhibited their widespread implementation:

- Fear of and lack of knowledge on the part of management and staff about the consequences of prescribed fire.
- A lack of confidence and credibility on the part of those who are supposed to do the job.

There are other issues that tend to fog the issue—money, not enough people to do the job, smoke, etc. With these concerns in mind, the training staff set out to build the trainees' confidence, with hopes that as they improved their skills, fears would fade.

The training started out in a classroom setting. Trainees were provided overviews of resource opportunities and constraints by local resource specialists. Meeting resource management objectives by varying burning techniques was emphasized. Methods of predicting scorch heights, duff, and woody fuel consumption were reviewed. A fire's effect was related to the subject resource by fire intensity and duration.

### Hands-On Training

The group was split into five teams and assigned to production burning jobs. The training staff team leader acted as burning boss and instructor. Project objectives were compared to burn plans and prescription parameters. Constant monitoring of fire behavior and spontaneous critiques helped trainees recognize causes and effects of subtle changes in fuels, burning technique, and weather (fig. 1).

The second week started in the classroom. Building a burn plan that

**Figure 1**—*Constant communications with all members of the training team were maintained. The prescribed fire manager and burning boss maintained tight control over the project, ensuring that the prescription was adhered to.*

met specific objectives outlined in an environmental analysis was the first day's goal. After 2 days of classroom work and 4 days of burning under the direction of the instructors, each group was assigned several areas to prepare burn plans for. When their plans nearly matched the school solution, the trainees carried out their plans, criticizing performance versus expectations continuously.

At the end of 3 weeks the trainees had burned 3,500 acres to meet a variety of resource management objectives (fig. 2). The confidence and expertise levels of the trainees were improved by their concentrated exposure to operational prescribed burning.

**Figure 2**—*On-the-stump calculations were the responsibility of the prescribed fire manager. Some burns had such narrow windows that new calculations had to be made every 15 minutes.*

The training has really caught hold. It was difficult to get 24 trainees to sign up for the first session. Nearly 100 have already applied for the 50 positions planned for this year. This year's plans include considerable one-on-one discussions, onsite, with fire weather forecasters, as well as the preparation of a video tape covering the highlights of the workshop for those who cannot attend. ■

# Transition Training

**Jim Whitson and Marvin Newell**

*Florida Division of Forestry, Tallahassee, FL, assigned to the FIRETIP Project; and Project Leader, FIRETIP Project. Both are stationed at the USDA Forest Service, Boise Interagency Fire Center, Boise, ID.*

Transition training permits the movement of individuals currently qualified in the National Interagency Fire Qualifications Standards (NIFQS) large fire organization or agency-specific fire organization to a comparable position in the incident command system (ICS).

Transition training packages are currently available for positions in the operations, planning, and logistics sections. Transition training in the finance section will consist of successfully completing I–220 (Basic ICS) because those positions remain essentially unchanged from their NIFQS/large fire organization (LFO) counterparts.

The process begins with management review of the qualifications of individuals to be transferred to ICS to ensure that they are qualified at their currently certified level. Individuals who are only marginally qualified or inexperienced at their currently certified level should be considered for transition to the next lower level in ICS. Testing has indicated that personnel who are not fully experienced and qualified cannot be transferred successfully to comparable ICS positions at an adequate performance level.

The transition training process is *not* appropriate for use in upgrading personnel to higher level positions and must *not* be used for that purpose.

All trainees must first successfully complete I–220. The balance of the process, depending upon the specific transition training package, generally consists of 4 to 8 hours of position review, individual exercises, and a group simulation exercise. The transition training package is designed so that the students complete several projects before the classroom session. In the classroom the students use appropriate forms and interact with individuals in other ICS positions. This interaction gives the students a better understanding of the system and how their positions are related to other positions.

It is recommended that persons holding command and general staff positions participate in a team simulation exercise. The team exercise can be extracted from the I–420 training course and should be conducted with qualified ICS personnel acting as coaches and moderators. The exercise needs to focus on team interaction according to ICS management concepts.

The comparison list may be used as a guide in selecting currently qualified NIFQS/LFO personnel for transfer to the National Interagency Incident Management System (NIIMS)/ICS. Agencies using systems other than NIFQS/LFO will need to develop their own comparison lists.

Transition training packages for planning, operations, and logistics may be ordered from:

Bureau of Land Management, Boise Interagency Fire Center, 3905 Vista Avenue, Boise, ID 83705; telephone (208) 334-9807 or (FTS) 554-9807.

**Table 1**—*Fire position comparison list for transition training*

| ICS position | LFO position |
|---|---|
| Incident commander | Fire boss |
| Safety officer | Safety chief |
| Liaison officer | Interagency liaison officer |
| Information officer | Fire information |
| | **Operations section** |
| Operations section chief/Branch director | Line boss |
| Division/Group supervisor | Division boss |
| Task force leader (multiresource) | Sector boss |
| Strike team leader/Task force leader | |
| Crew | Sector boss |
| Dozer | Tractor boss |

**Table 1**—*Fire Position Comparison List for Transition Training—Continued*

| ICS positions | LFO positions |
|---|---|
| Engine | Tanker boss |
| Staging area manager | No transition |
| Air operations director | Air service officer and Air attack boss |
| Air attack supervisor | Air attack boss |
| Air tanker coordinator | Air tanker boss |
| Helicopter coordinator | Helicopter boss |
| Air support supervisor | Air service officer |
| Helibase manager | Air service manager heliport I |
| Helispot manager | Air service manager heliport II |
| | **Planning Section** |
| Planning section chief | Plans chief |
| Resources unit leader | Maps & records officer |
| Status recorders | None |
| Check-in recorders | None |
| Situation unit leader | Intelligence officer |
| Field observer/Display processor | Line scout/General scout |
| Demobilization unit leader | Demobilization officer |
| Documentation unit leader | Maps & records officer |
| Fire behavior prediction specialist | Fire behavior officer |
| | **Logistics Section** |
| Logistics section chief/Service-support branch director | Service chief |
| Medical unit leader | None |
| Communications unit leader | Communications officer |
| Incident head dispatcher | None |
| Incident dispatcher | None |
| Food unit leader | Food manager |
| Supply unit leader | Supply officer |
| Ordering manager | None |
| Receiving and distribution manager | None |

**Table 1** —*Fire Position Comparison List for Transition Training—Continued*

| ICS positions | LFO positions |
|---|---|
| Facilities unit leader | Camp officer |
| Security manager | Security officer |
| Base manager | Camp officer |
| Camp manager | Camp officer |
| Ground support unit leader | Equipment officer |
| Equipment manager | Tractor manager<br>Tanker manager |
| | **Finance section** |
| Finance section chief | Finance chief |
| Cost unit leader | Obligation officer |
| Compensation/Claims unit leader | Claims officer and compensation for injury officer |
| Procurement unit leader | Supply officer |
| Time unit leader | Time officer |

# Planting Smokey Bear's Tree

**Patsy Cockrell**

*Fire Prevention Information Assistant, USDA Forest Service, Cooperative Fire Protection, Washington, DC.*

The USDA Forest Service and the Foresters' Wives Club of Washington, D.C., planted a blue spruce in ceremonies on April 11, 1984, honoring Smokey's 40th birthday. The tree was planted on the 14th Street side of the U.S. Department of Agriculture Administration Building. R. Max Peterson, Chief of the Forest Service, acted as the master of ceremonies.

After the presentation of the colors and the pledge of allegiance, Jan Peterson, wife of the chief and president of the Foresters' Wives Club of Washington, D.C., introduced John B. Crowell, Jr., Assistant Secretary of Agriculture. Mr. Crowell spoke about the savings of billions of dollars for the American taxpayer through the 40-year-old Smokey Bear forest fire prevention campaign.

John R. Block, Secretary of Agriculture, spoke on the importance of planting trees and on how well Smokey's message about preventing forest fires had been accepted and put into practice by the general public.

Frank Hardin and Jackson Weaver of WMAL radio station, Washington, DC, were introduced by Chief Peterson. Jackson Weaver, the original official radio voice of Smokey, told the story of Smokey Bear and then introduced Smokey Bear to those attending the ceremonies.

Secretary Block, Chief Peterson, Mrs. Peterson, Mr. Hardin, Mr. Weaver, Woodsy Owl, and Smokey Bear all helped place the soil around the blue spruce. ■

# "Adopt a Safe Burning Barrel" Project

**William Schultz**

*Manager, Barnesville Fire Protection Area, Ohio Division of Forestry, Barnesville, OH.*

Debris burning is a significant cause of wildfires throughout Ohio. Frequently, household debris and litter are burned in unsafe, rusted-out barrels with no lids or screens or, even more often, directly on the ground. A recent change in our fire reporting system allows us to target our fire prevention efforts in big fire areas. One fire protection area in the eastern Ohio hill country is implementing a project to reduce the number of wildfires resulting from debris burning. The objectives of the project, called "Adopt a Safe Burning Barrel," were identified as follows:

- To provide safe containers for residents of a specific area to burn their debris in.
- To inform residents about safe outdoor burning practices.
- To promote awareness of the Division of Forestry and cooperating local fire departments.

## Supply of Barrels

The success of the program depended upon locating an adequate supply of 55-gallon barrels at little or no cost to the Division. A survey of obvious sources (highway departments, salvage yards, mining operators, landfills, trash collectors/ haulers, oil companies, etc.) led to other potential suppliers. Drum reconditioners, industries that check and refurbish drums for reuse and frequently offer rejects for general sale, are located mostly in distant major cities, so that this source was not first choice.

A landfill operator reported that a dairy routinely delivered material to the site in drums. Orange juice concentrate from Florida is shipped to the United Dairy, Martins Ferry, Ohio, in drums of the appropriate size. The drums were not routinely reused because cost of return exceeded the deposit recovered. The dairy was happy to participate in the burning barrel project.

During the search, barrels that might have contained unknown materials or residues of toxic or flammable substances were not considered.

## Barrel Modification

The barrels all had removable lids with a retaining ring. The retaining ring was removed and cut into 14- to 16-inch lengths and welded to the top of the lid for use as handles (two handles per lid). A cutting torch was used to put holes into the lid, so that it could be used as a screen. In addition, the word *forestry* was cut into some of the lids (fig. 1). However, doing this was too time consuming. These lids are light enough to permit easy operation; equally acceptable lids can be made from screen or mesh material. Air vent holes were cut into the bottom of the barrel.


**Figure 1**—*Lid of the burning barrel.*

The names of the Division of Forestry and the cooperating fire department were stenciled onto the sides of the barrel for at least temporary identification during distribution.

Had demand for the barrels exceeded the capability of the local forces, a vocational school or school shop could have assisted in the production. The intention, however, is that once the program is established, the fire department will take over the barrel modification as well as distribution.

### Local Cooperation

A rural fire department with a strong prevention attitude and community minded members, the "Spirit of '76" Volunteer Fire Department of eastern Belmont County, was chosen to be the cosponsor of the project. One attraction of the burning barrel project was that it allowed the fire department to give something to the residents instead of asking for contributions.

### Publicity

Media coverage of the project was an essential ingredient for success. The presentation of the first barrel, to a local State legislator, received newspaper and television coverage at the start of spring fire season. A barrel display at a local mall and a ½-hour public service program on television provided additional pro-


**Figure 2**—*The adoption certificate.*

motion. As evidenced by the initial response, the project could have quickly escalated beyond the original target area, for residents and fire departments of adjoining areas wanted to participate.

### Distribution

The 230 barrels were distributed from the fire station. With each barrel went a "Certificate of Adoption" (fig. 2), a flyer of instructions for safe burning procedures, and a handout of general fire-season and safety information, including reference to EPA regulations.

Department members collected information from the "adopters. A file card containing the adopter's name, address, phone number, and date was completed at the time of distribution. This card is maintained by the Division and will be used throughout the year for mailing information about any special prevention programs. A followup mailing in a year is planned to check on the success of the adoption and condition of the barrel—will it be rusted out and in need of replacement?

### Summary

The 230 original barrels have been distributed as planned. Although only time will determine the effect of the project on fire occurrence, through the efforts of cooperating industry and public agencies, increased public awareness about prevention and fire safety has certainly been achieved.

Further information can be requested from William Schultz at (614) 425-2621. ■

# Calculating Fire Size and Perimeter Growth

**Hal E. Anderson**

*Supervisory Research Physicist, USDA Forest Service, Northern Forest Fire Laboratory, Missoula, MT.*

*"Headquarters, this is fireguard Smith. We have a fire out here on Ryegrass Flats by County Road 12 that is really moving out! The two of us can't contain this one! Can you send help?"*

*"Smith, this is headquarters. Yes, we'll send reinforcements. Tell us the fire and weather conditions out there so we can estimate your needs."*

*"OK. We have a few clouds and the temperature is about 80 °F. The wind turned high and gusty about an hour ago at 2 p.m. and is about 15 to 20 miles per hour now. Trees along the creek are bending. The fire is burning in grass; and the dead grass is dry; grass stems snap in two when bent. Jones climbed on the pickup and says the fire head has probably reached the next road about a quarter mile away! It couldn't have started more than 10 minutes ago. The fire is no more than 200 yards wide!"*

*"Ten-four, Smith. We'll get on this. Do what you can along the flanks and see if the fire jumped that section of road. We'll get back to you."*

How reasonable are these field observations? What is the possibility that this fire could become a big one? Fire managers now have the tools to calculate fire behavior values for forward rate of spread, perimeter, and growth in area *(6)*. The calculated values can be compared with the field observations and a "first look" established for the fire size. The sooner the fire fighting and support staffs develop a common perspective of the fire, the sooner effective fire management action can be taken. This paper describes a graphic technique that helps the fire manager visualize the fire's potential for growth, the wind's effect on fire shape, and the relationship of size and perimeter.

## Background

Today's fire managers have a variety of methods for calculating rate of spread, size, perimeter, and other characteristics of fire behavior. Much of what is available now has been the result of activities since the mid-1970's when fire behavior training was refined. Material presented by Albini *(1)* with the use of nomograms has been expanded upon for use with a handheld calculator by Burgan *(4)*. In addition, this material has been tailored for the various fire behavior training courses of the National Advanced Resource Technological Center, Marana, AZ, or by fire management agencies. Finally, these techniques have been summarized by Rothermel *(6)* and have been adapted for the 1980 Fireline Handbook *(7)*. Fire size and perimeter have been estimated using the ellipse as a general form for the initial burning period. Anderson *(2)* recently documented the use of the ellipse for initial fire shape and perimeter and showed how the values fit actual fire records.

The relationships of fire area, perimeter, and fire shape (length-to-width ratio, or l/w) were described by Anderson *(2)* and illustrated in a graphic plot of all three variables (fig. 1). This provides a means for comparing field observations with calculated estimates. It also provides a graphic projection to help visualize fire growth and to recognize (a) potential for large size, (b) effective suppression activities as they limit growth, and (c) the effects of wind, moisture, terrain, and fuels on fire size and shape.

## Description of Projection Method

Field observations must be combined with certain known factors to allow comparison to calculated estimates. In addition, these comparisons and subsequent ones provide the data for projecting fire growth and the potential for a big fire.

The first observations on a wildfire usually include how far the head of the fire has traveled and wind velocity. Combining these observations with fire shape (fig. 1) and using spread distance to estimate perimeter allows one to determine the fire size (fig. 2). The steps involved are

(1) Convert observed windspeed (miles per hour) to the wind velocity acting on the flame. Multiplying the estimate of the 20-foot-high winds by 0.5 will approximate midflame windspeed. If information on fuels and vegetation is available, use the guides provided by Rothermel (*6*, p.

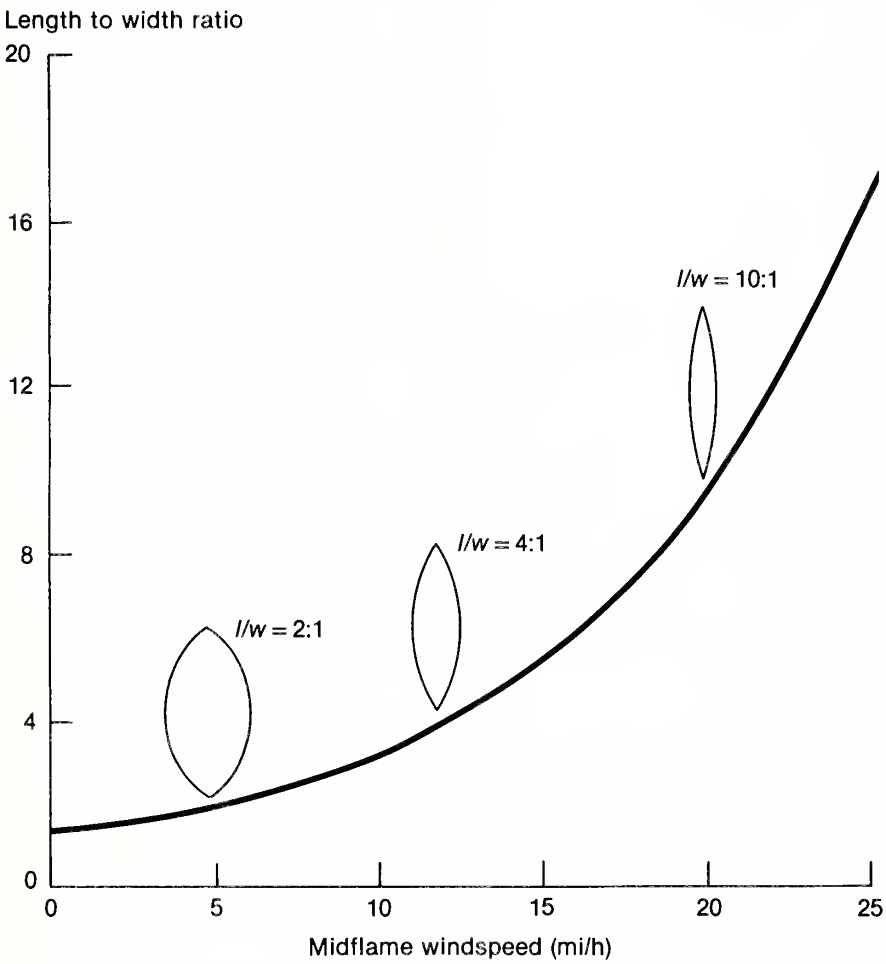


**Figure 1**—*Effect of length to width ratio and windspeed on fire shape.*

33) for a better value.

(2) Enter the windspeed value into figure 1 and find the curve intersection; read the l/w on the vertical scale and note this value.

(3) Multiply the spread distance (chains) by 3 to approximate the perimeter and note this value.

(4) Enter values from steps 2 and 3 above into figure 2; the intersection defines the fire size or area (acres) for those two values.

Fire size (acres) is displayed along the left-hand axis of figure 2; the l/w is along the bottom; and the perimeter scale along the right-hand side matches the lines they lie next to.

Ever since Hornby's *(5)* aids to fire planning became available nearly 50 years ago, the size and perimeter of fires have been evaluated in terms of three values: minimum, probable, and maximum. The same concept is incorporated into figure 2; the vertical line at a l/w of 1.0, labeled *0 percentile,* is the minimum value. All fires will be to the right of this line. The sloping line labeled *50 percentile* defines the probable value and has just as many fires to the left of the line as to the right of the line. The second sloping line, labeled *92 percentile,* describes the maximum value, and 92 of every 100 fires will be to the left of the line.

The 50 and 92 percentile values for each interval of fire size, in acres (1 to 10 acres to 10 to 100 acres, etc.), and the perimeter in chains were obtained from fire report records in the Northern Region between 1960 and 1969. A total of 13,448 fire records were screened, and 13,444 were sorted into each interval for analysis (table 1). Data for fires of less than 1 acre were not used because no values for area or perimeter were documented. This reduced the number of records used to 2,304.

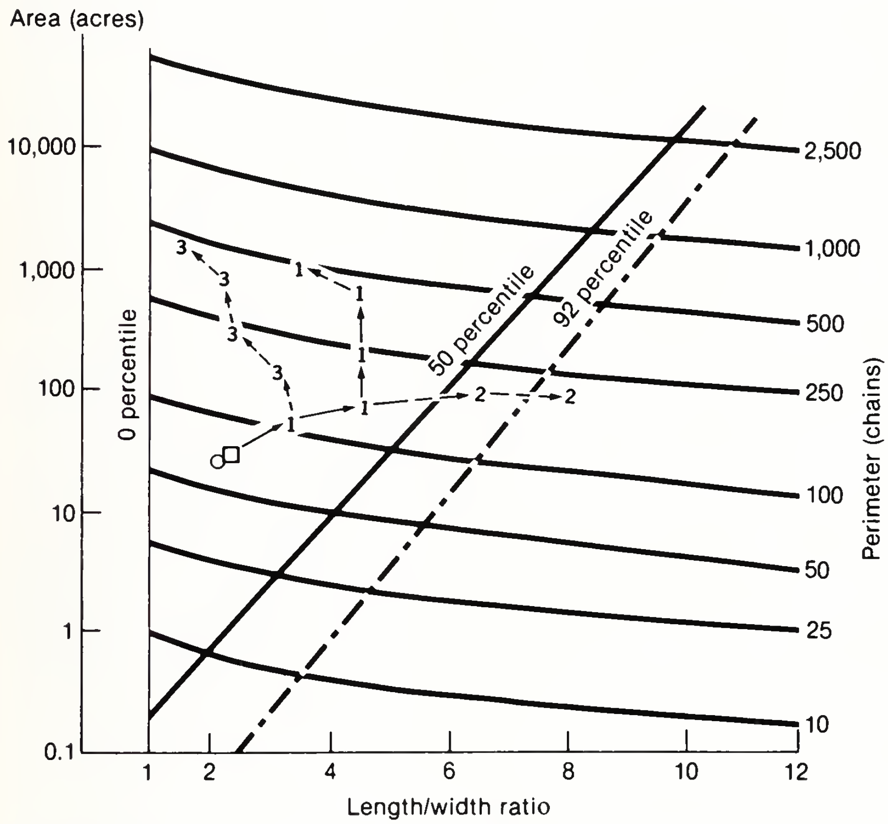


**Figure 2**—*Chart for determination of fire size, with examples in text.*

**Table 1**—*Distribution of fires by size*

| *Fire size* | *No. of fires* | *Percent of total* |
|---|---|---|
| <1 acre | 11,140 | 82.86 |
| 1–10 | 1,778 | 13.23 |
| 10–100 | 389 | 2.89 |
| 100–1,000 | 103 | .77 |
| 1,000–10,000 | 31 | .23 |
| >10,000 | 3 | .02 |
| Total | 13,444 | 100.00 |

Other regions, States, and management units can analyze their fire records and establish values to determine differences.

The probable and maximum values of figure 2 differ from Hornby's. Plotted on figure 2, Hornby's values would be vertical lines at l/w ratio of 5:1 for probable and 9.7:1 for maximum. The difference can be partly attributed to the size of the data base available for analysis. In addition, as fires increase in size, the perimeter increases more rapidly because of changes in fuels, terrain, and winds. These changes cause irregularities in the perimeter that are in addition to the perimeter growth of a wind-driven fire over flat topography. This could contribute to the slope of the 50 and 92 percentile lines.

## Application

Let's return to the hypothetical fire. From the conditions reported and other information available, the dispatcher proceeded to estimate fire size. From the temperature and the relative humidity of 30 percent, he estimated dead fuel moisture content at 5 percent. The wind in the treetops of 15 to 20 miles per hour was reduced to midflame height by Rothermel's (*6*) adjustment factor of 0.4 (15 miles per hour times 0.4 equals 6 miles per hour). The slope was 0, so rate of spread was about 150 chains per hour, as read from Rothermel's (*6*) nomograms. Because the estimated burning time

was 10 minutes, actual spread distance was one-sixth of 150 chains or 25 chains. The fireguard, Smith, reported about a ¼-mile (80 chains/mile × ¼ mile = 20 chains) spread distance, which is in reasonable agreement with the calculated spread of 25 chains.

Calculated values for the area (acres) and the perimeter (chains) can be obtained from any of several methods already mentioned. The Texas Instrument TI–59 calculator, S–390 tables *(3)*, or the 1980 Fireline Handbook *(7)* will yield calculated estimates for perimeter of about 72 chains and for area of about 34 acres. These values are entered into figure 2 and are represented by the square symbol. Remember, the vertical scale for area is logarithmic, and small misplacements of points may result in large differences in acres. This fire does not appear to be a potentially severe fire, but additional projections are needed to really evaluate the situation.

Several checks of the field observations are possible also. From figure 1 and the steps outlined earlier, using the 6-miles-per-hour windspeed on the fire, we find a l/w ratio of about 2.2 to 1. An l/w ratio estimate is possible from Smith's observations that the fire had traveled ¼ mile (20 chains) and was 200 yards (600 feet ÷ 66 feet/chain = 9.1 chain) wide. These values yield an l/w ratio of 2.2 (20 chains ÷ 9.1 chains = 2.2) and reinforce the accuracy of the field observations.

We can proceed to estimate the perimeter as three times the spread distance, or 60 chains (20 chains × 3 = 60 chains). At an l/w ratio of 2.2 on figure 2, we move vertically to just above the sloping line representing 50 chains of perimeter to establish the data point, represented by the circle, at 60 chains and an area of about 30 acres.

This procedure has accomplished two things. First, we have checked the reasonableness of field observations. Second, a base point has been established from which growth can be projected and where additional field data can be plotted and fire growth observed.

**Projections**

The possible fire growth sequences can be plotted by the dispatcher or other fire managers so that a visual story of the fire's history and future can be projected. Fire weather forecasts and information from the fire site can be used to develop trends in fire size.

Using the example, let's project possible trends for some weather or suppression influences.

A. Assume that weather forecasts indicate winds increasing to 20 to 25 miles per hour for the next 2 hours, remaining steady through the evening, and then gradually decreasing in velocity. From figure 1 we can determine the probable l/w and combine that with a calculated spread distance or perimeter for a projected growth trend. The increasing wind elongates the fire shape as shown by the 1's to the right of the initial fire position in figure 2. The steady high winds constrain the fire shape to a constant l/w ratio as shown by the vertical 1's. As the winds die down the head fire and flank fires move at more nearly the same rate and the l/w ratio decreases.

B. If, before the winds reach their maximum speed, suppression forces attack the flanks of the fire, keeping the width of the fire small, then the l/w ratio would continue to increase as the fire was pinched off. (This type of suppression action may contribute to the slope of the lines defining the 50 percent and 92 percent boundaries in figure 2.) This behavior is depicted by the left-hand 2. If, however, the wind rapidly increases to nearly 40 miles per hour at the 20-feet level, the resulting 18-to 20-mile per hour wind on the fire would push it into a long, narrow fire depicted by the right-hand 2 symbol. Such conditions could result in one of the 8 out of 100 fires with potential to become large.

C. Assume the weather forecast predicts rising winds and the passage of a front with a 90-degree change in wind direction. A fire with an increasing l/w ratio, the first 1 from the initial fire, now swings 90 degrees and advances along a flank that is now the fire front. The l/w ratio decreases, but the area and perimeter increase, as shown by the

3's in figure 2. Many fires that experience shifting winds and irregular terrain will show similar fire growth trends. Some of these have been presented by Anderson *(2)* and provide additional insights.

## Summary

Using data from field observations and the fire behavior calculation methods currently available, fire specialists can develop a graphic impression of how a fire's size and shape may change during its history. This could prove helpful for analysis, particularly wilderness fires, during initial fire growth. Estimates of windspeed and distance traveled allow a "first look" with minimum input. Information on fuels, weather, and terrain enhance the ability to project fire growth trends.

This projection technique is useful for checking field observations, estimating fire potential as compared to historical records, and learning how weather and other factors influence fire size and shape.

Fire management specialists who would like to implement this technique can photocopy figure 1 and figure 3, a "clean" copy of figure 2. Sample copies of both figures for reproduction in quantity are available from the author.

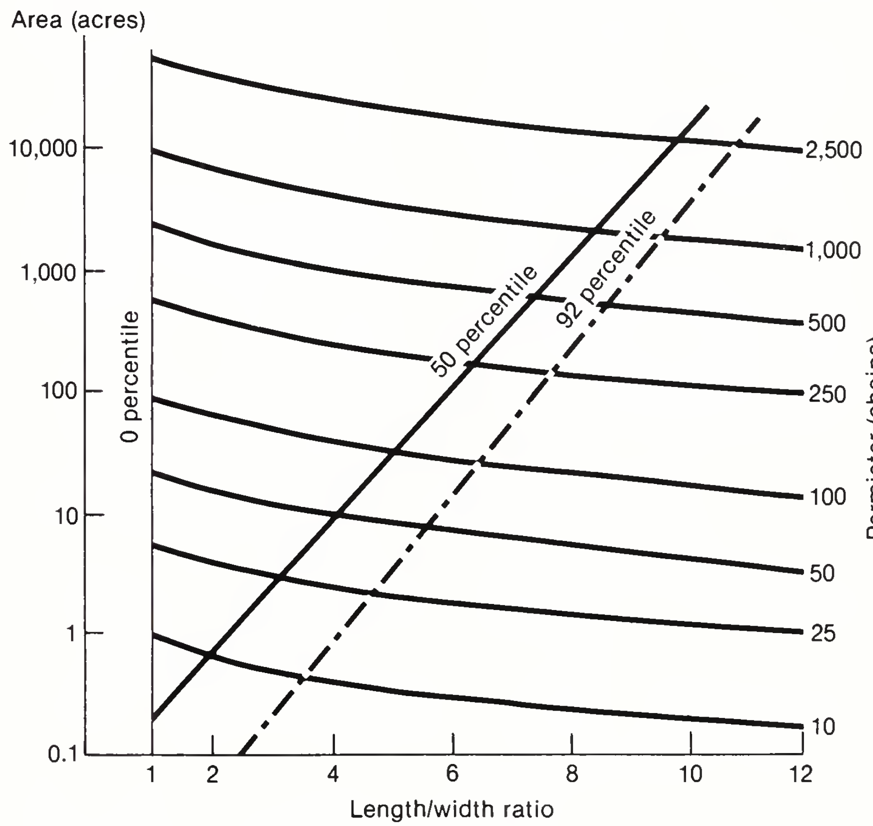


**Figure 3**—*Chart for determination of fire size, with no examples, so that it can be copied.*

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